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Outcomes of esophageal dilation in eosinophilic esophagitis: Safety, efficacy, and persistence of the fibrostenotic phenotype

Thomas M. Runge, MD MPH[1], **Swathi Eluri, MD**[1], **Cary Cotton, BA**[1], **Caitlin M. Burk, BA**[1], **John T. Woosley, MD PhD**[3], **Nicholas J. Shaheen, MD MPH**[1,2], and **Evan S. Dellon, MD MPH**[1,2]

[1]Center for Esophageal Diseases and Swallowing, University of North Carolina School of Medicine, Chapel Hill, NC

[2]Center for Gastrointestinal Biology and Disease, Division of Gastroenterology and Hepatology, Department of Medicine; University of North Carolina School of Medicine, Chapel Hill, NC

[3]Department of Pathology and Laboratory Medicine; University of North Carolina School of Medicine, Chapel Hill, NC

Abstract

Objectives—Esophageal dilation is commonly performed in eosinophilic esophagitis (EoE), but there are few long-term data. The aims of this study were to assess the safety and long-term efficacy of esophageal dilation in a large cohort of EoE cases and determine the frequency and predictors of requiring multiple dilations.

Methods—We conducted a retrospective cohort study in the University of North Carolina EoE clinicopathological database from 2002-2014. Included subjects met consensus diagnostic criteria for EoE. Clinical, endoscopic, and histologic features were extracted, as were dilation characteristics (dilator type, change in esophageal caliber, total number of dilations) and complications. Patients with EoE who had undergone dilation were compared to those who did not and also stratified by whether they required single or multiple dilations.

Results—Of 509 EoE patients, 164 were dilated a total of 486 times. Those who underwent dilation had a longer duration of symptoms prior to diagnosis (11.1 vs. 5.4 yrs, $p<0.001$). 95 patients (58%) required >1 dilation (417 dilations total, mean of 4.4 ± 4.3 per patient). The only

Corresponding Author: Evan S. Dellon MD, MPH, CB#7080, Bioinformatics Building, 130 Mason Farm Rd., UNC-CH, Chapel Hill, NC 27599-7080, Phone: (919) 966-2513, Fax: (919) 843-2508, edellon@med.unc.edu.

Guarantor of the article: Evan Dellon

Specific author contributions (all authors approved the final draft):
Runge – data collection, data analysis and interpretation, manuscript drafting, critical revision, approved final draft
Eluri – data collection and interpretation, critical revision, approved final draft
Cotton – data collection and interpretation, critical revision, approved final draft
Burke – data collection and interpretation, critical revision, approved final draft
Woosley – pathology supervision, data collection, critical revision, approved final draft
Shaheen – project supervision, data interpretation, critical revision, approved final draft
Dellon – project conception and supervision, data collection and interpretation, manuscript drafting, critical revision, approved final draft

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predictor of requiring multiple dilations was a smaller baseline esophageal diameter. Dilation was tolerated well, with no major bleeds, perforations, or deaths. The overall complication rate was 5%, primarily due to post-procedural pain. Of 164 individuals dilated, a majority (58%, or 95/164) required a second dilation. Of these individuals, 75% required dilation within 1 year.

Conclusions—Dilation in EoE is well-tolerated, with a very low risk of serious complications. Patients with long-standing symptoms prior to diagnosis are likely to require dilation. More than half of those dilated will require multiple dilations, often needing a second procedure within one year. These findings can be used to counsel patients with fibrostenotic complications of EoE.

Keywords

Eosinophilic esophagitis; esophagael dilation; fibrostenosis; food impaction; complication

Introduction

Eosinophilic esophagitis is a recently recognized condition characterized clinically by symptoms of esophageal dysfunction and histologically by esophageal eosinophilia, after excluding secondary causes (1-3). Common symptoms are dysphagia, food impaction, chest pain, abdominal pain, and vomiting (2, 4-6). The prevalence of EoE has markedly increased over the past two decades (7-13) and it is now a major contributor to health care costs (14).

Chronic eosinophilic inflammation is known to cause a number of mechanical complications in the esophagus secondary to fibrosis (15-17). This inflammatory cascade results in esophageal rings, narrowing, strictures, and mucosal fragility, termed crêpe-paper mucosa (18-23), which lead to clinical manifestations of dysphagia as well as food impaction, of which EoE is now the most common cause (24, 25). Although some anti-inflammatory therapies may help improve fibrosis at the microscopic level (26, 27), esophageal dilation has become an accepted mechanical therapy in EoE (1, 6, 20, 23, 28-33) and can be an effective treatment for these symptoms (29, 31, 33-36). However, published experience to date with dilation remains somewhat limited (37, 38), and there are few long-term outcomes known. In our clinical experience, many EoE patients require multiple dilations over time, but this not been extensively investigated.

The aims of this study were to assess the safety, efficacy, and tolerability of esophageal dilation in a large cohort of EoE cases, assess outcomes, and determine the frequency and predictors of requiring multiple dilations.

Methods

We conducted a retrospective cohort study using the University of North Carolina EoE clinicopathological database. The details of this database have been described previously (23, 39-42). The database contains EoE cases of all ages from March 2002 through June 2014. Briefly, included patients met consensus guidelines for a new diagnosis of EoE (1, 2). Patients were required to have ≥ 15 eos in at least one high-power field (HPF) despite 8 weeks of proton pump inhibitor therapy. Patients had to have one or more typical symptoms of esophageal dysfunction, such as dysphagia, heartburn, food impaction, or feeding

intolerance, and other causes of esophageal eosinophilia were excluded. Only incident, not prevalent, cases were included.

Clinical information was extracted from the medical record on both a per-patient and per-dilation basis to determine demographics, endoscopic findings, number of dilations performed, initial and final esophageal diameter, type of dilator used (wire-guided bougie [Savary] vs through-the-scope [TTS] balloon), and any concomitant medical or dietary treatment. Patients were studied from the time they were diagnosed with EoE forward. If a stricture was present at diagnosis, dilation was performed if indicated. Therefore, dilation could be done before, after, or concomitantly with topical corticosteroid or dietary elimination therapy (1, 3). Dilations were performed by the attending gastroenterologist, who also selected the dilation technique based on their preference and the clinical scenario. In general, if a focal stricture was identified, standard TTS balloon technique (stationary dilation) was used. If there was a markedly narrowed esophagus or a severe stricture such that the adult upper scope would not pass, then typically a neonatal scope was used and Savary dilation was performed. If diffuse narrowing or multifocal strictures were seen, the balloon pull-through technique could be utilized, at the discretion of the endoscopist. In brief, this technique involves inflation of a TTS balloon across the GEJ, followed by slow withdrawal of the endoscope and balloon from distal to proximal esophagus (43). If resistance is encountered, the balloon is positioned across that area and slowly reinflated. If no resistance if encountered, the balloon is deflated and the esophagus is inspected for mucosal trauma. If no trauma is seen, the process is repeated with the next largest balloon diameter.

A repeat dilation was considered planned if specific follow-up was scheduled; it was unplanned if the indication was for recurrent symptoms after prior successful treatment. In general, planned follow-up was scheduled for patients with tight strictures or a diffusely narrowed esophagus. In this setting a patient was scheduled for repeat dilation every 4-6 weeks until a symptomatic response was achieved, and the esophagus had been dilated to a diameter of at least 15mm. However, the timing could vary based on the severity of the stricture and the concomitant EoE treatment, with shorter intervals for more severe strictures.

Complications of dilation (esophageal pain/discomfort, chest pain requiring medical attention or hospitalization, any ER visit, bleeding, perforation, or death) were also assessed. Post-procedure discomfort was defined as chest pain for which analgesics were prescribed or an ER visit was needed. Bleeding was defined as intra- or post-procedural bleeding for which the patient required endoscopic or other therapy or management in a health care facility. Perforation was defined as extravasation of contrast material on esophagogram or the presence of pneumomediastinum on CT scan. Measurements of esophageal luminal diameter were taken from the endoscopists' report; if it was not clearly stated, it was extrapolated from the diameter of the dilators used. This method has been used in prior studies of dilation in EoE (29, 33), with the understanding that estimating the esophageal lumen can be difficult based on visual assessment alone (44). Information on symptom response to dilation was obtained from medical records. Because this was a retrospective

study, symptom response was dichotomized (yes/no) based on patient global report, a method that we have previously used successfully (41, 42).

Statistical analysis was performed with Stata version 13 (Statacorp, College Station, TX) using data collected on a per-patient level as well as a per-dilation level. Descriptive statistics were used to summarize data, and bivariate analyses were performed using Student's t-test, chi-square, or Fisher's exact test where appropriate to compare EoE cases who did and did not require dilation. Multiple logistic regression was used to determine predictors of needing dilation. We also compared results of patients undergoing balloon vs Savary dilation, patients who received a single dilation compared with those who required multiple dilations, and characteristics stratified by provider type (senior author vs other endoscopists). This study was approved by the University of North Carolina Institutional Review Board.

Results

Patient and dilation characteristics

Of 509 patients identified with an incident diagnosis EoE, 164 (32%) required esophageal dilation. A total of 486 dilations were performed (mean 3.0 ± 3.7 dilations per patient). For 191 of the dilations (40%) patients were on a concomitant topical steroid, and for 73 (15%) patients were on concomitant dietary elimination therapy. The median follow-up time was 15.1 months (IQR: 5-48 mos), and ranged from 0 mos to 13.5 years.

Compared to EoE cases who did not require dilation, those who underwent dilation were more likely to be white (89% vs. 79% $p<0.001$) and have a longer duration of symptoms prior to diagnosis (11.1 vs. 5.4 yrs, $p <0.001$) (Table 1). Clinical factors associated with requiring dilation included dysphagia (OR 21.5; 95% CI 9.26-50.0), food impaction (OR 2.61; 1.75-3.90), absence of heartburn (OR 1.75; 1.17-2.65), and absence of abdominal pain (OR 4.25; 2.30-7.87). Endoscopic factors associated with receiving dilation included the presence of rings (OR 5.59; 3.71-8.42) and lack of a normal baseline endoscopy (OR 14.42; 4.46-46.5). In the multivariate regression model which included age at diagnosis, dysphagia, the presence of rings on endoscopy, an abnormal baseline endoscopy, and the absence of heartburn, the presence of dysphagia was the strongest predictor of requiring esophageal dilation (OR 8.45; 3.45-20.7). Other factors independently associated with dilation were absence of heartburn (OR 1.79; 1.08-2.96), the presence of rings (OR 1.87; 1.10-3.17) and an abnormal baseline endoscopy (OR 6.62; 1.42-30.9). Of note, in both bivariate and multivariate analyses, the baseline eosinophil count did not predict dilation.

Safety

Post-dilation complications identified included hospitalization in 2 patients (0.4%), pain requiring medical attention in 21 (4%), and emergency department evaluation in 5 (1%) (Table 2). Both hospitalized patients were treated for aspiration pneumonia with antibiotics and were discharged in good condition. There were no major bleeds, perforations, or deaths. The overall complication rate per procedure was 5%. Stratified by type of dilation, those dilated with through-the-scope (TTS) balloon dilators tended to have fewer complications

(Table 3), but this was not significant (4% vs 10%; p=0.10). Information on post-dilation discomfort was available for 46% (223/486) of procedures, and in these cases, 41% (91/223) reported some degree of discomfort following dilation. The frequency of discomfort was not different for bougie vs TTS dilators (44% vs. 40%, p=0.57).

Efficacy and dilation technique

TTS dilators were used in 81% of procedures, and wire-guided bougie dilators were used in 19%. Overall, between each patient's first and last dilations, esophageal diameter improved from 12.5 ± 3.0 mm to 15.2 ± 2.9 mm (Table 2). On a per-patient basis, information on symptomatic response was available for 124 patients. Of these, 108 (87%) had a symptomatic response to dilation overall. On a per-procedure basis, symptom response information was available for 153 procedures, and patients reported improved symptoms after 130 (85%). Symptom response was similar for those on either dietary or topical steroid therapy (88%) compared to those on neither therapy (81%). Of the 45% of patients not on concomitant medical or dietary treatment for EoE at the time of dilation, one-third of dilations occurred on high-dose PPI alone at the time of EoE diagnosis, and for another third patients had stopped EoE medications prior to their dilation due to non-adherence, expense, or because they had run out. There were few differences in outcomes between patients who had balloon vs bougie dilation (Table 3).

Half of the patients (n=82) were dilated by a single provider (ESD). When comparing this sub-group to those treated by the other endoscopists, there were few major differences in baseline clinical, endoscopic, or histologic features (data not shown). A total of 248 dilations were performed by the single provider, compared with 238 for other providers, and techniques and dilation characteristics were largely similar overall (Supplemental Table 1).

Multiple dilations and dilation timing

At total of 95 patients (58%) required multiple dilations. Those undergoing multiple dilations comprised 417 dilations, for a mean of 4.4 ± 4.3 dilations per patient; 36 patients (22%) required 4 or more dilations. The median follow-up time in this group was 31 months (IQR: 12-62 mos).

There were few clinical differences between those undergoing multiple dilations and a single dilation (Table 4). However, those who received multiple dilations had a smaller esophageal diameter prior to dilation (11.3mm vs. 12.5mm, p=0.01) and ultimately achieved greater increases in esophageal diameter (4.9 vs. 3.0 mm, p<0.001). However, on a per-dilation basis the gains were modest. For example, these individuals achieve only a 1.1mm mean increase per session, compared to 3.0mm in those dilated once. Those with multiple dilations were also more likely to have a symptomatic response to dilation (94% vs. 80%, p=0.014) and to be dilated using bougie dilators (35% vs. 19%, p=0.02).

These patients also had frequent need for dilation, as the median interval between dilations was 3 months (IQR: 2-8 mos). The median time from the first to the second dilation was 4 months (IQR: 2-11 mos), and the median time from first to last dilation was 14 months (IQR: 5-42 mos). Overall, 75% (73/95) of those requiring multiple dilations, and 45% of the entire cohort (75/164), underwent a second dilation within one year. Of those receiving

multiple dilations, 213 dilations (68%) were planned for continued stricture treatment; 98 dilations (32%) were provoked by patient symptoms. 60% of those receiving planned dilations were on medications; among those with unplanned dilations, only 45% were on medical therapy. Information on the temporality of patients' second and third dilations is shown in Figure 1. Additionally, as the number of dilations required increased, the intervals between dilation became shorter. Those who required three or fewer dilations had significantly longer dilation-free periods than those who required 4 or more (33 vs. 7 months, p=0.01).

Discussion

Esophageal dilation is frequently utilized in EoE to treat complications of longstanding fibrostenotic disease such as rings, strictures, and a narrow-caliber esophagus (29, 31-33, 36-38). The aims of this study were to update the safety, efficacy, and tolerability of esophageal dilation in a large cohort of EoE cases as well as to assess outcomes, particularly related to the frequency and predictors of requiring multiple dilations. Among our large cohort of EoE patients, about one-third required esophageal dilation. In addition, the majority of these individuals needed multiple dilations, with more than one-fifth requiring 4 or more. This implies that once esophageal remodeling has occurred in EoE, it is not easily reversible even by mechanical means. We also found that over the course of nearly 500 dilations, a number that increases the published experience by approximately 50%, the procedure was both safe and effective.

Previous studies have shown that between one-quarter and one-third of adult EoE patients require esophageal dilation (29, 31, 33, 36, 45). In our cohort, individuals received 3 dilations on average per patient, which is higher than the average of 1.2 – 2.2 dilations per patient reported in the literature (29, 31, 33, 36). However, a recent abstract showed that in some EoE patients, yearly dilations were required to maintain esophageal patency (31, 46). Our data suggest that dilation may often be needed at shorter intervals. The exact reason for multiple dilations is not clear, but possible explanations include failure of medical or dietary therapy, patient refusal or inability to tolerate chronic treatment, practice variation with dilation being performed more frequency at the index/diagnostic endoscopy, and referral patterns with EoE patients with more severe strictures being seen at our tertiary care center. Regardless of the reason, the need for multiple dilations in adult EoE patients is not necessarily unexpected. There is a known association between duration of symptoms and stricture formation (20, 23). From a mechanistic standpoint, both eosinophils and mast cells produce TGF-β, which in turn recruits fibroblasts, promotes epithelial mesenchymal transition, and increases smooth muscle contractility, all of which contribute to esophageal remodelling in EoE (15-17, 34, 37, 47-50). It is hypothesized that longstanding inflammation and ongoing fibrotic changes result in the phenotype of strictures, rings, and narrow caliber esophagus seen in adult patients (17, 20, 23, 51, 52). In our population with longstanding (>10 year) symptom duration prior to diagnosis, this may explain the frequent need for multiple dilations.

Few data are available to guide endoscopists on dilation technique (1, 3, 6, 53), and techniques used for dilation in EoE differ across centers, with some centers having a

preference for balloons (29, 33) and others preferring bougies (31, 36, 54, 55). Among 6 recent large studies that have reported 1069 dilations in EoE patients, 37% were performed using balloon dilators, and 63% of which were performed using bougies (29, 31, 33, 36, 54, 55). Some authors suggest using bougie dilators when complex strictures or diffuse narrowing are encountered (32, 52, 55, 56), but others advocate the size control and direct visualization afforded by TTS balloons (43, 57). Our data showed that both techniques were safe and effective. Given similar published safety and efficacy parameters and little comparative data on the two types of dilation, endoscopists are guided by the clinical circumstance, as well as likely their own preference and experience with dilation (36, 58). Future studies comparing specific dilation methods across a variety of clinical scenarios are needed to help further guide endoscopists treating strictures in EoE.

In terms of dilation efficacy, these methods significantly increased esophageal caliber and improved symptoms in 85% of cases in which follow-up information was available. This proportion is comparable to that reported in the literature, which ranges from 81% - 92% (29, 31, 33, 37). It is important to note, however, that esophageal diameter measurement were inferred from the dilator sizes used, and symptomatic improvement was graded as a yes/no dichotomous variable only. For safety, we had no major complications of bleeding perforation, or death, which is also consistent with recent literature (57, 59, 60). We also reported two hospitalizations following dilation, both due to aspiration pneumonia. Aspiration pneumonia is not necessarily a complication of dilation itself, but given the retrospective study design we could not distinguish if the pneumonia was due to the dilation or the endoscopy. A review on esophageal dilation in EoE found an overall perforation rate of 0.6% among all published studies, and a rate among recent studies of only 0.3% (58); similar rates were found in 2 meta-analyses (37, 38). One recent prospective trial of dilation also found no major complications (61). Of note, these figures are close to the overall rate of perforation from dilation quoted for any indication, 0.1-0.4% (53).

An issue that remains unanswered is the durability of esophageal dilation in EoE. Of patients in our study who required multiple dilations, a majority (75%) required repeat dilation within one year, and these patients were dilated a median of 4 months after their first dilation. The timeframe for repeat dilation among our patients is shorter than has been seen previously (31). The exact reason for this difference is not known, but possible explanations include differences in the dilation technique and target diameter for dilation, variability between endoscopists, incomplete control of inflammation, and patient phenotype. Other studies suggest that repeated dilations over an “induction” period are needed for patients with severe fibrostenotic EoE (55), and we employ a similar practice in patients with severe or diffuse esophageal strictures or narrowing. However, prospective studies examining the durability of dilation among distinct phenotypes of EoE patients would better practice.

Our study has several limitations. The first is its retrospective design. Information about esophageal caliber had to be inferred from the diameter of the endoscopic equipment used. It is possible that complications could have been under-reported due to the retrospective design, as our figures of post-procedure pain are lower than what have been previously reported. In addition, the retrospective design of our study limited our ability to know precisely what proportion of patients derived symptomatic improvement from dilation, and

to what degree a patient derived improvement in tolerance of solid foods. The coding of symptomatic improvement as a yes/no variable meant that we could not grade the degree of symptom relief. For those who were symptom responders, we could not entirely separate the effect of the dilation from the effect of concomitant pharmacologic or dietary treatment. However, in order to mitigate this effect we stratified response rates by therapy and found comparable symptom response rates regardless of whether there was concomitant anti-inflammatory therapy or not, indicating dilation likely contributes significantly to symptomatic improvement in the patients we studied. Another possible limitation is the use of differing dilation techniques at our center. There was no standardized protocol for what type of dilator to use; instead, the type of dilator used was chosen at the discretion of the endoscopist, based on their preference and the clinical scenario. The balloon pull-through technique, utilized by some providers at our center, involves controlled withdrawal of an inflated balloon from the GEJ to the cricopharyngeus, done at increasing sizes until resistance and/or dilation effect are seen (43). This technique can involve reintubation of the esophagus in some cases, adding time to a procedure. In addition, any balloon-based dilation technique involves increased cost. In the future, comparative studies on dilation techniques could clarify if balloons or bougies are more effective in EoE. Finally, because of the specialized experience available at our center, it may be difficult to extrapolate the results to other practice setting, including those in the community, that are less familiar with dilation in EoE. However, even though approximately half of the dilations in this study were performed by the senior investigator (ESD), there were few major differences between patient, dilation, and outcome characteristics by provider.

These limitations are balanced by the strengths of this study which include a large and well-characterized cohort of EoE patients, a comprehensive data extraction protocol with exhaustive follow-up information on the vast majority of individuals receiving dilation, and the largest yet reported series of esophageal dilation in EoE comprising sizable patient groups treated with both balloons and bougies.

In conclusion, our data show that esophageal dilation is a safe and effective treatment for relief of symptoms related to esophageal stricture, rings, or generalized narrowing in EoE patients. Approximately one third of EoE patients require dilation, with longer duration of symptoms being an important predictor. Notably, of those who do require dilation, more than half will require multiple dilations and typically in a short time frame, a new finding that can be used to counsel patients who are found to have fibrostenotic complications of EoE. Future studies could address the extent to which symptoms and diet can improve with esophageal dilation, the comparative effectiveness of different dilator types, and how anti-inflammatory therapy following esophageal dilation may minimize the need for repeat dilation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Study Highlights

What is current knowledge?

- Patients with eosinophilic esophagitis may require esophageal dilation to treat symptoms of dysphagia due to esophageal strictures or narrowing
- Little is known about the long-term efficacy about dilation or predictors and frequency of requiring multiple dilations

What is new here?

- Approximately 1/3 of EoE patients required esophageal dilation, and of those requiring a single dilation almost 60% required multiple dilations, the majority of which were performed within a year.
- The only predictor of requiring multiple dilations was a smaller baseline esophageal diameter.
- Dilation was tolerated well, with no major bleeds or perforations.
- Bougie and through-the-scope balloon dilators performed similarly

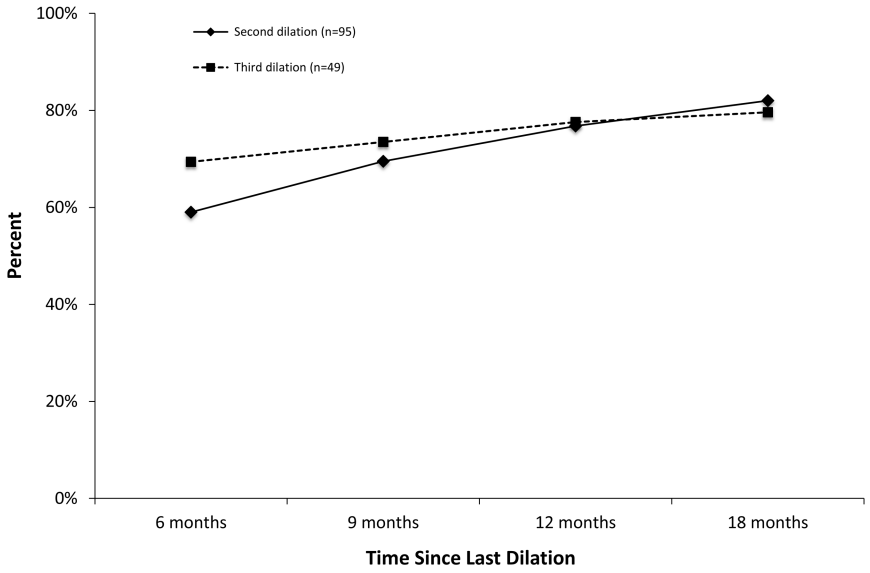

Figure 1.

Temporality of repeat esophageal dilation in EoE. This graph shows the proportion of EoE patients who required repeat dilation in 6, 9, 12, and 18 months. The solid black line indicates the proportion who required a second dilation after their first procedure, and the dashed line indicates the proportion who required a third dilation after their second procedure.

Table 1

Characteristics of patients with eosinophilic esophagitis, comparing those requiring dilation to those not requiring dilation

	No Dilation (n = 345)	Dilation (n = 164)	p*
Age at diagnosis (mean yrs ± SD; range)	20.7 ± 17.6 (0.6-73.5)	38.6 ± 15.2 (10.7-82.0)	<0.001
Adults (≥ 18 year; n, %)	110 (36)	134 (91)	< 0.001
Symptom length prior to diagnosis (mean yrs ± SD)	5.4 ± 6.8	11.1 ± 11.1	<0.001
Males, n (%)	251 (73)	112 (68)	0.30
White, n (%)	269 (79)	143 (89)	0.006
Symptoms, n (%)			
Dysphagia	186 (55)	157 (96)	<0.001
Food impaction	89 (27)	73 (49)	<0.001
Heartburn	144 (43)	45 (30)	0.007
Chest pain	32 (10)	19 (13)	0.33
Abdominal pain	95 (28)	13 (9)	<0.001
Vomiting	105 (32)	26 (17)	0.001
Failure to thrive	54 (16)	3 (2)	<0.001
EGD Findings, n (%)			
Normal	72 (21)	3 (2)	<0.001
Rings	107 (31)	118 (72)	<0.001
Stricture	11 (3)	82 (50)	<0.001
Narrowing	21 (6)	50 (30)	<0.001
Furrows	154 (45)	89 (54)	0.06
Crepe-paper mucosa	15 (4)	8 (5)	0.81
White plaques	89 (26)	49 (30)	0.38
Erythema	27 (8)	10 (6)	0.46
Decreased vascularity	73 (21)	42 (26)	0.30
Erosive esophagitis	90 (26)	44 (27)	0.93
Max eosinophil counts (mean eos/HPF ± SD)	79.1 ± 75	81.8 ± 77	0.71

SD, standard deviation; *eos*, eosinophils; *HPF*, high-power field

* *P* values calculated using Student's t-test for continuous variables and chi-squared test for categorical variables.

Table 2

Efficacy and Safety of Dilation

	Any Dilation (n = 164)
Total number of dilations	486
Number of dilations per patient (mean ± SD)	3.0 ± 3.7
Dilation Method, n (%)	
Savary	91 (19)
Balloon	395 (81)
Esophageal diameter (mm) before dilation (mean ± SD)	12.5 ± 3.0
Esophageal diameter (mm) after final dilation (mean ± SD)	15.2 ± 2.9
Increase in esophageal diameter (mean mm ± SD)	2.6 ± 1.4
Symptom response, n (%)[‡]	108 (87)
Complications, n (%)	
Any complication	25 (5.1)
Pain	21 (4.3)
Bleeding	0 (0)
ER visit	5 (1.0)
Hospitalization	2 (0.4)
Perforation	0 (0)
Death	0 (0)

[‡]Symptom response data available for n=124

Table 3

Characteristics and Performance of Dilation, by Type of Dilator Used

	Balloon (n = 395)	Savary (n = 91)	p
Max eosinophil count (mean eos/hpf ± SD)	55.8 ± 53.5	58.7 ± 72.2	0.73
On meds at dilation, n (%)	162 (42)	29 (34)	0.19
On diet at dilation, n (%)	60 (16)	13 (18)	0.90
Esoph diameter (mm) before dil (mean ± SD)	12.5 ± 2.9	12.7 ± 3.6	0.55
Esoph diameter (mm) after dil (mean ± SD)	15.3 ± 2.9	14.5 ± 2.7	0.02
Increase in esoph diameter (mean mm ± SD)	2.8 ± 1.2	1.8 ± 1.5	<0.001
Symptom response, n (%)*	106 (87)	24 (77)	0.34
Complications, n (%)‡			
Any complication	16 (4)	9 (10)	0.10
Pain	16 (4)	5 (6)	0.53
Bleeding	0	0	N/A
ER visit	1 (0.3)	4 (4)	0.005
Hospitalization	1 (0.3)	1 (1.1)	0.34
Perforation	0	0	N/A
Death	0	0	N/A

*Symptom response data available for n= 153 individual dilations)

‡More than one complication (i.e., pain followed by er visit) occurred following a single dilation in n=6 cases.

Table 4

Comparison of EoE Patients Requiring One Dilation to those requiring Multiple Dilations

	Single Dilation (n = 69)	Multiple Dilations (n = 95)	p
Age at diagnosis (mean yrs ± SD)	39.0 ± 16.4	38.2 ± 14.3	0.74
Symptom length prior to dx (mean yrs ± SD)	9.4 ± 10.7	12.2 ± 11.2	0.18
Males, n (%)	49 (71)	63 (66)	0.52
White, n (%)	58 (85)	85 (91)	0.23
Symptoms, n (%)			
Dysphagia	65 (94)	92 (98)	0.22
Food impaction	30 (49)	43 (48)	0.92
Heartburn	23 (38)	22 (25)	0.09
Chest pain	8 (13)	11 (12)	0.92
Abdominal pain	7 (11)	6 (7)	0.34
Failure to thrive	1 (2)	2 (2)	1
Food allergies	11 (22)	19 (23)	0.91
Any atopic disease	21 (34)	38 (43)	0.31
Endoscopic findings at baseline, n (%)			
Rings	49 (71)	69 (73)	0.82
Narrowing	17 (25)	33 (35)	0.17
Stricture	30 (44)	52 (55)	0.16
Linear furrows	39 (56)	50 (53)	0.62
White plaques	21 (30)	28 (29)	0.89
Decreased vascularity	18 (26)	24 (25)	0.91
Max eosinophil count (mean eos/HPF ± SD)	76.3 ± 59.5	85.7 ± 87.5	0.44
Histologic response (% <15 eos/HPF), n (%)*	17 (57)	32 (48)	0.42
Dilation Method, n (%)‡			
Savary	12 (18)	32 (34)	0.03
Balloon	57 (82)	87 (93)	0.05
Esoph diameter (mm) before dilation (mean ± SD)	12.5 ± 2.8	11.3 ± 2.9	0.01
Esoph diameter (mm) after dilation (mean ± SD)	15.7 ± 3.0	16.2 ± 2.4	0.30
Esoph diameter (mm) increase (mean ± SD)	3.0 ± 1.3	4.9 ± 2.5	<0.001

*Post-dilation biopsy information available for n=97 individuals

‡Proportions total >100% as some individuals (n=25) underwent procedures using both types of dilators